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Donaghey

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(54) **SYSTEMS AND METHODS THAT IDENTIFY NORMAL TRAFFIC DURING NETWORK ATTACKS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1074 days.

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Related U.S. Application Data

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(51) **Int. Cl.**
H04J 3/16 (2006.01)

(52) **U.S. Cl.** **370/465**; 370/389; 726/23

(58) **Field of Classification Search** 370/235, 370/252, 238, 410, 432, 401; 709/224, 240; 713/201, 162
See application file for complete search history.

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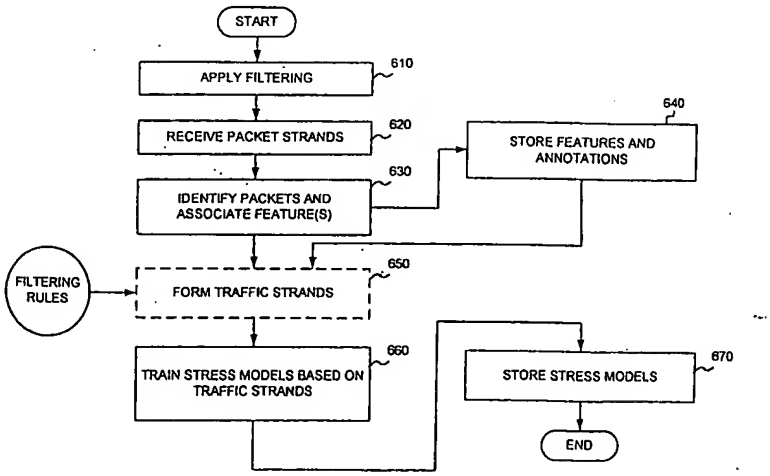
(57) **ABSTRACT**

A system protects against loss of communication during network attacks. In a first implementation, a system (**120**) models the behavior of normal users in a network in response to an application of a first packet filtering technique. The system (**120**) receives a group of packets from a first user subsequent to the application of the first packet filtering technique and creates one or more models reflecting the behavior of the first user based on the received packets. In another implementation, a system (**130**) receives a stream of packets subsequent to a filtering technique being applied, partitions the packets into groups, where each group corresponds to more than one packet, and classifies each group of packets as a normal group or an attack group using one or more models. Each model reflects a normal response to an application of the filtering technique. The system (**130**) forwards groups classified as normal groups, thus preventing network attacks from choking off all communication in the network.

17 Claims, 7 Drawing Sheets



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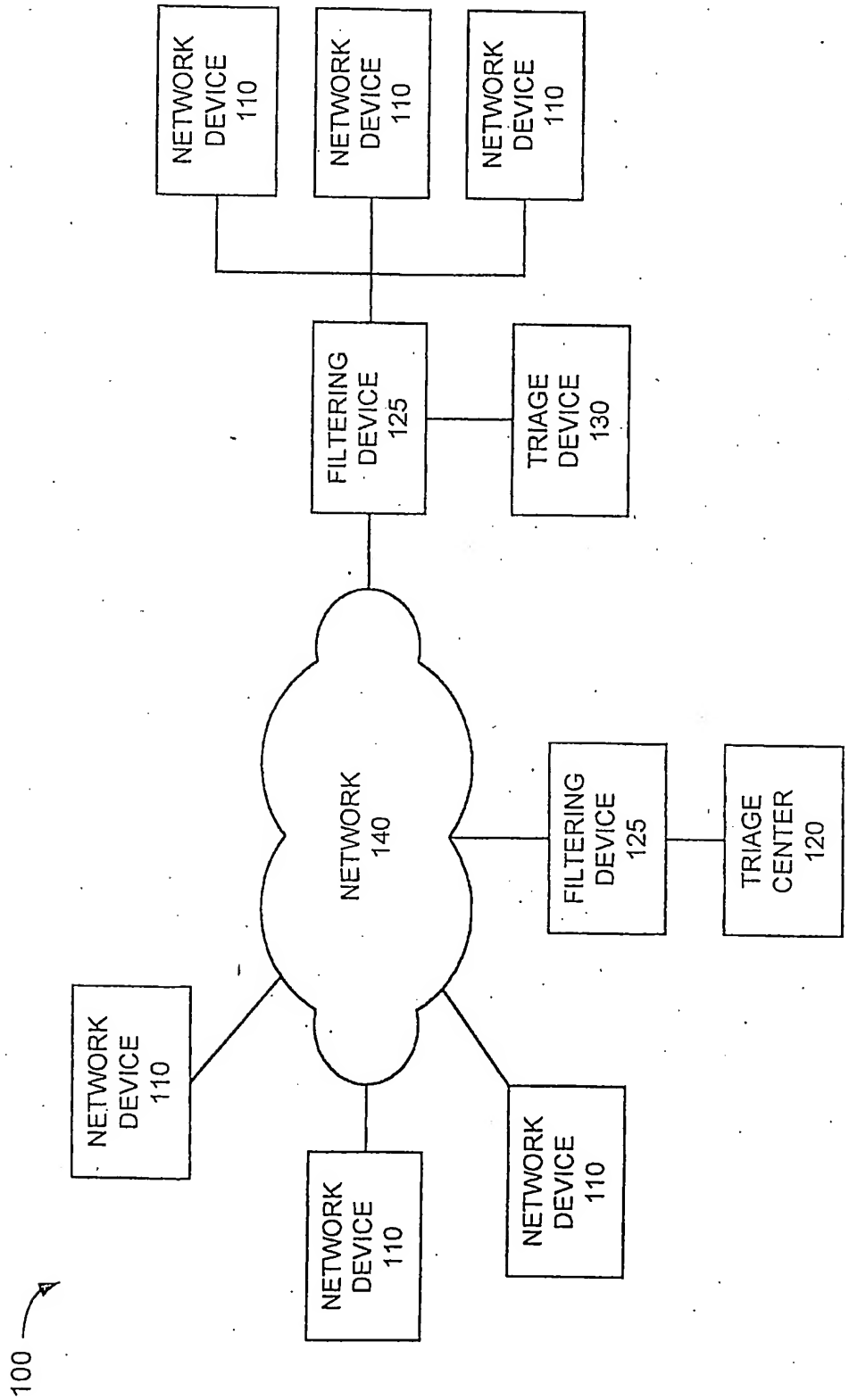
NETWORK DEVICE 110
NETWORK DEVICE 110
NETWORK DEVICE 110
FILTERING DEVICE 125
TRIAGE DEVICE 130
NETWORK 140
FILTERING DEVICE 125
TRIAGE CENTER 120
NETWORK DEVICE 110
NETWORK DEVICE 110
NETWORK DEVICE 110
100

FIG. 1

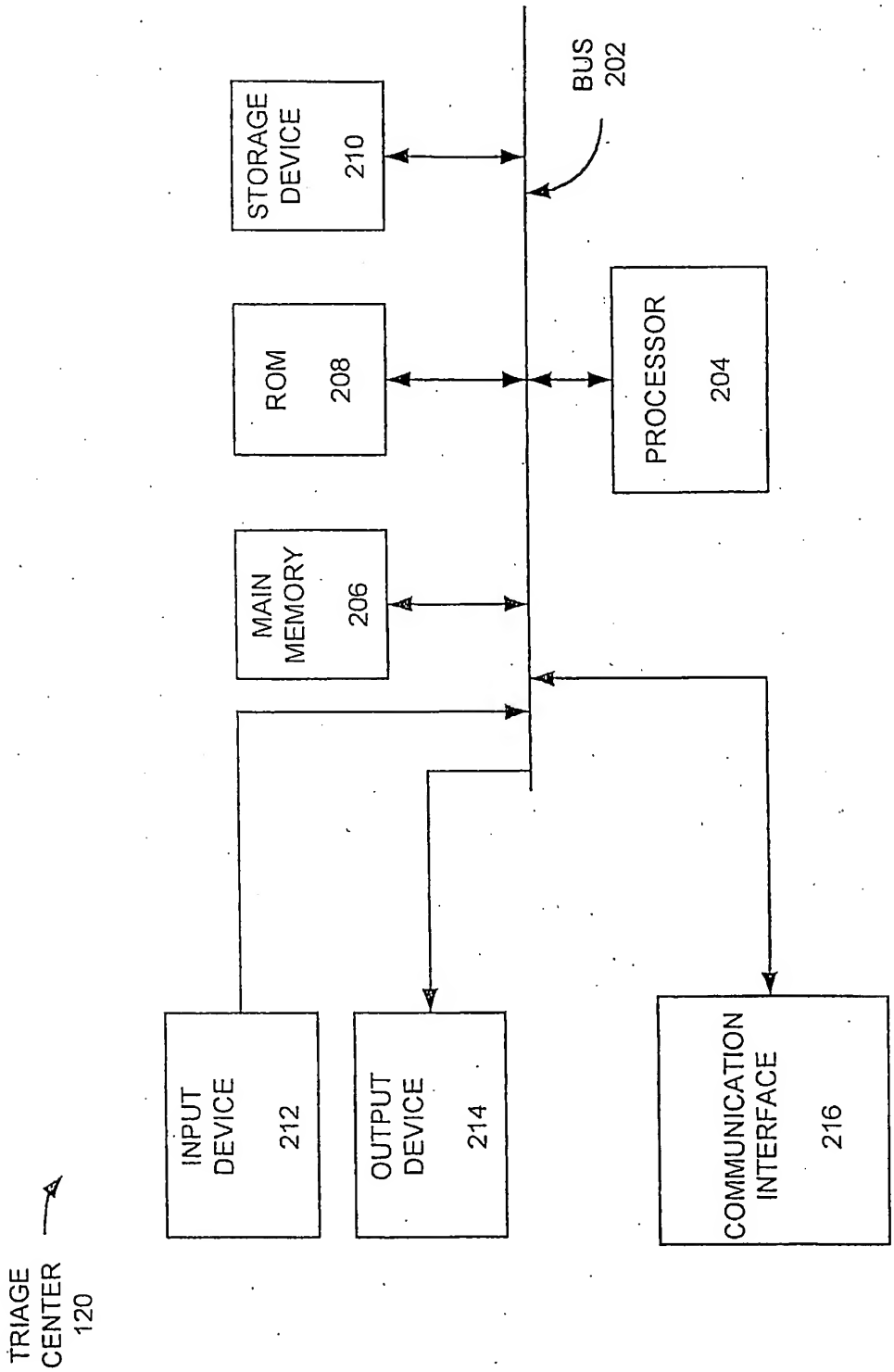
BUS
202
STORAGE DEVICE
210
ROM
208
PROCESSOR
204
MAIN MEMORY
206
INPUT DEVICE
212
OUTPUT DEVICE
214
COMMUNICATION INTERFACE
216
TRIAGE CENTER
120

FIG. 2

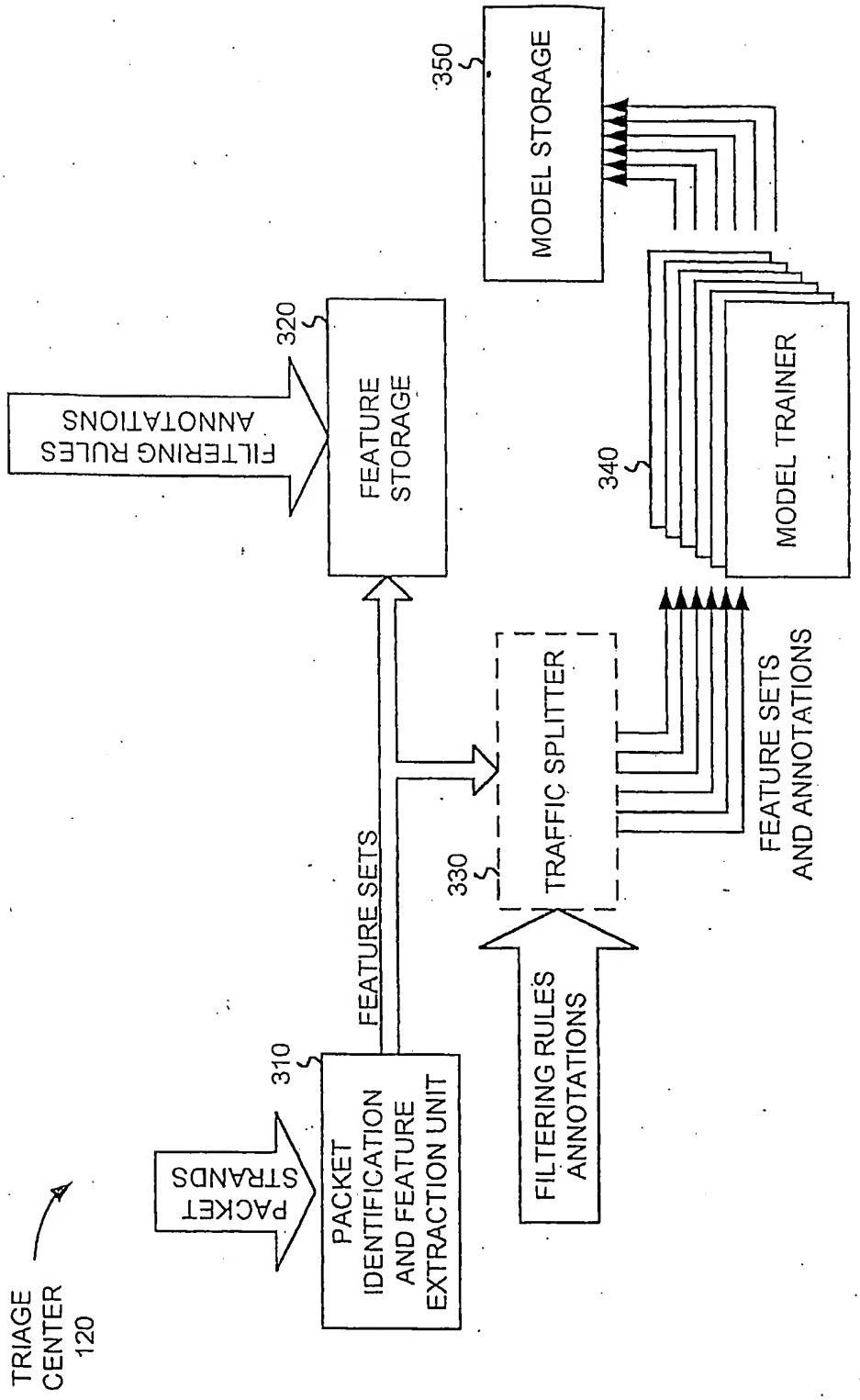
TRIAGE CENTER 120
PACKET STRANDS
310
PACKET IDENTIFICATION AND FEATURE EXTRACTION UNIT
FEATURE SETS
320
FEATURE STORAGE
FILTERING RULES ANNOTATIONS
330
TRAFFIC SPLITTER
FILTERING RULES ANNOTATIONS
FEATURE SETS AND ANNOTATIONS
340
MODEL TRAINER
350
MODEL STORAGE

FIG. 3

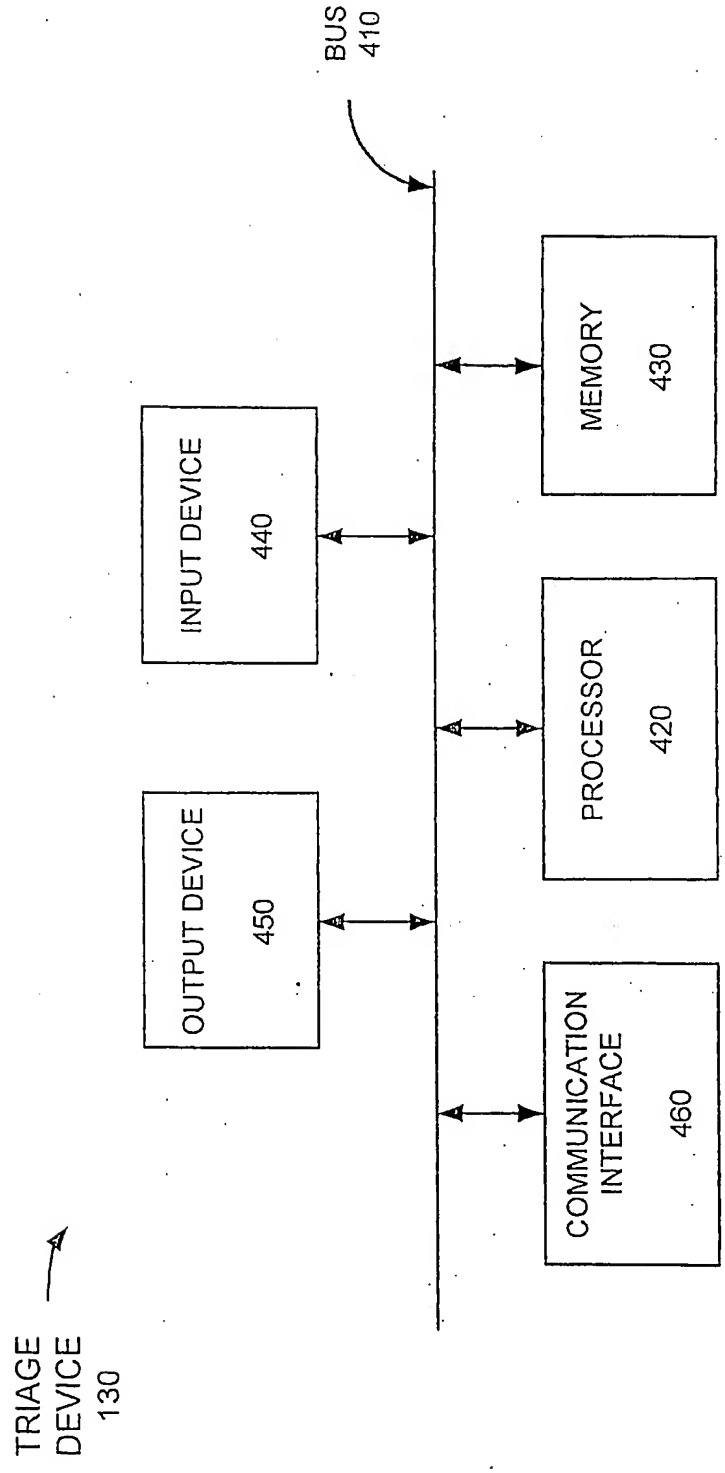
BUS
410
MEMORY
430
INPUT DEVICE
440
PROCESSOR
420
OUTPUT DEVICE
450
COMMUNICATION INTERFACE
460
TRIAGE DEVICE
130

FIG. 4

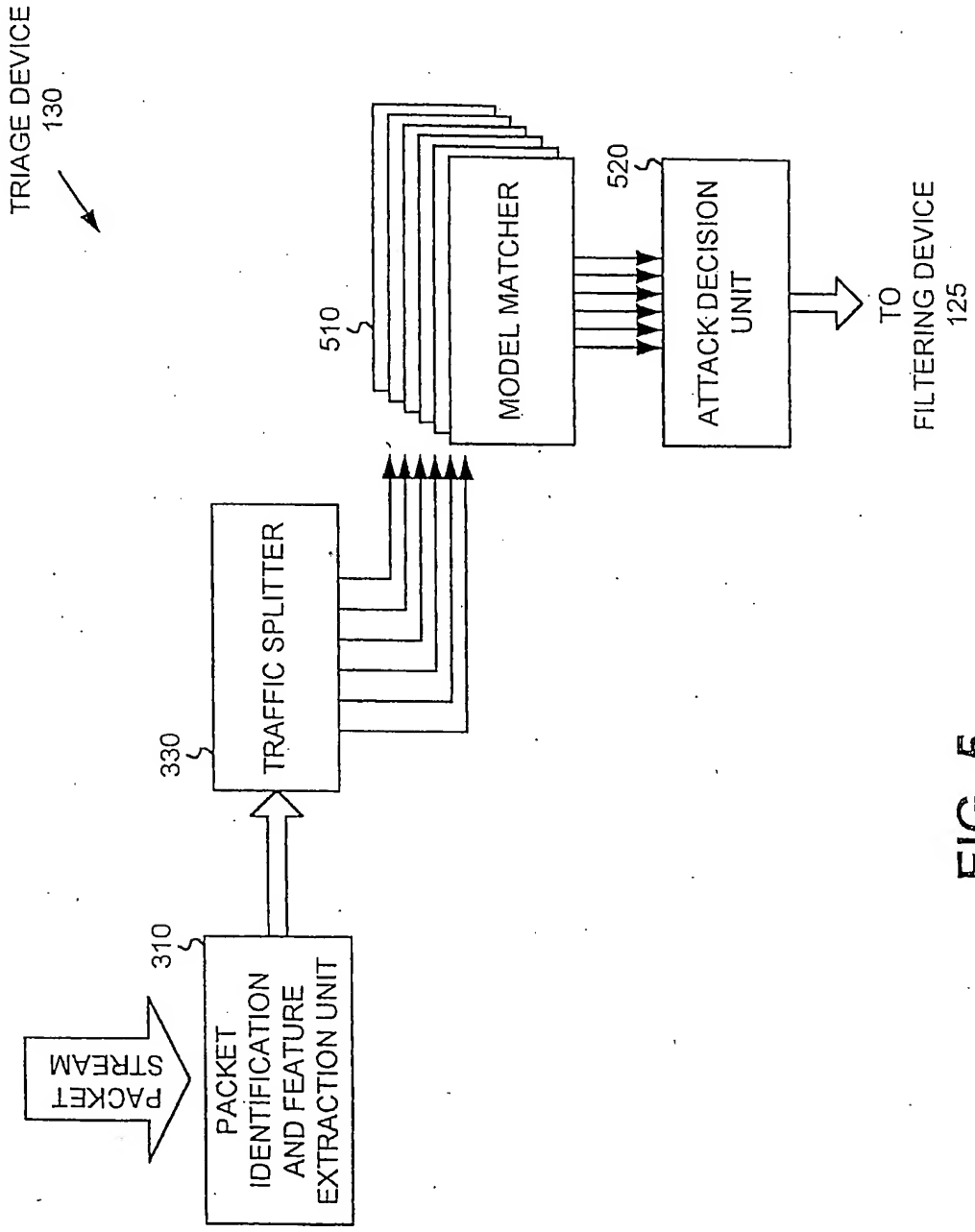
TRIAGE DEVICE
130
PACKET STREAM
310
PACKET IDENTIFICATION AND FEATURE EXTRACTION UNIT
330
TRAFFIC SPLITTER
510
MODEL MATCHER
520
ATTACK DECISION UNIT
TO FILTERING DEVICE
125

FIG. 5

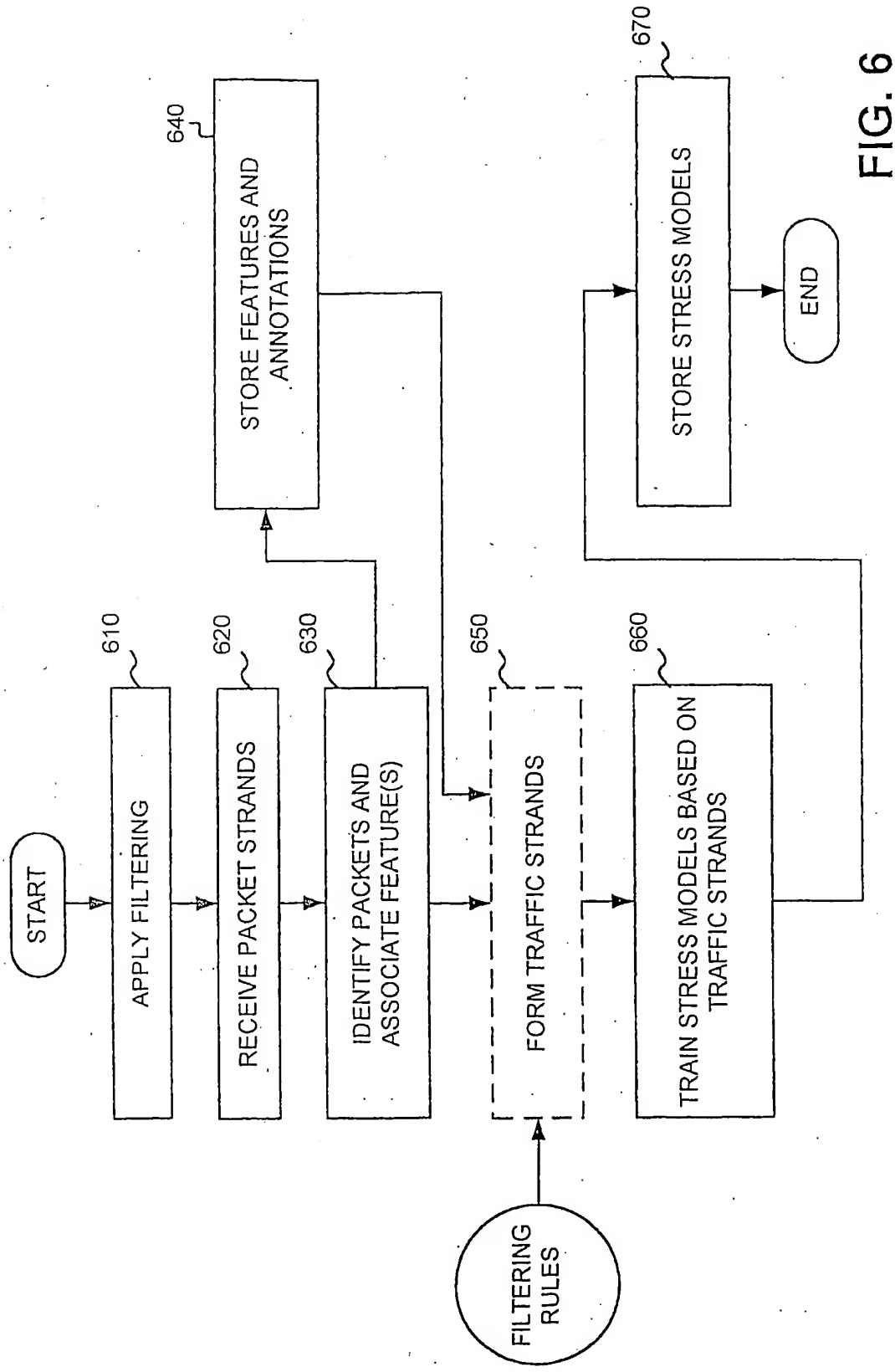
START
APPLY FILTERING
610
RECEIVE PACKET STRANDS
620
IDENTIFY PACKETS AND ASSOCIATE FEATURE(S)
630
STORE FEATURES AND ANNOTATIONS
640
FORM TRAFFIC STRANDS
650
TRAIN STRESS MODELS BASED ON TRAFFIC STRANDS
660
STORE STRESS MODELS
670
END
FILTERING RULES

FIG. 6

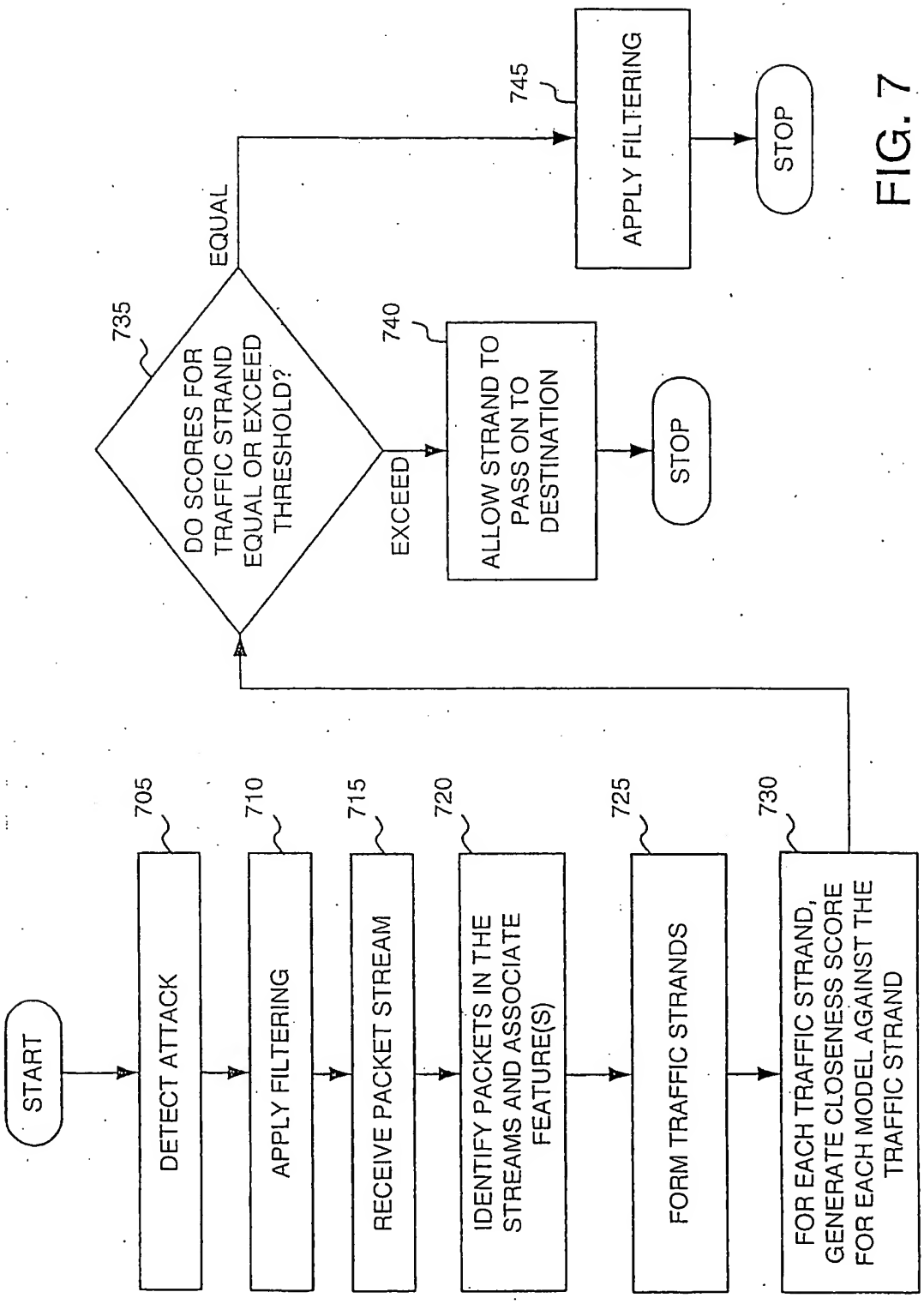
START
DETECT ATTACK
705
APPLY FILTERING
710
RECEIVE PACKET STREAM
715
IDENTIFY PACKETS IN THE STREAMS AND ASSOCIATE FEATURE(S)
720
FORM TRAFFIC STRANDS
725
FOR EACH TRAFFIC STRAND, GENERATE CLOSENESS SCORE FOR EACH MODEL AGAINST THE TRAFFIC STRAND
730
DO SCORES FOR TRAFFIC STRAND EQUAL OR EXCEED THRESHOLD?
735
EQUAL
EXCEED
ALLOW STRAND TO PASS ON TO DESTINATION
740
STOP
APPLY FILTERING
745
STOP

FIG. 7